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DAMAGE DETECTION OF A SIMPLY SUPPORTED STEEL BRIDGE STRUCTURE USING VIBRATION ANALYSIS

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Abstract. Damage detection in a structure is crucial to ensure safety, soundness, and proper maintenance. Early identification of cracks or defects can prevent catastrophic failures, reduce repair costs, and extend the life of the structure. This study focuses on a simply supported steel beam and employs a combined analytical, numerical, and experimental approach to identify and locate damage. Finite Element Analysis (FEA) is used to simulate beam behavior, extract acceleration data, and determine frequency responses through the Fast Fourier Transform (FFT). An experimental analysis is carried out using a CoCo-80 vibration analyzer to extract natural frequencies and mode shapes, which are analyzed to detect abnormalities in damage. To evaluate the applicability of the method in the real world, a transient analysis is performed that simulates a moving vehicle on a bridge, allowing the extraction of dynamic parameters under ambient loading. The results confirm that frequency shifts and changes in mode shape curvature are reliable indicators for detecting and localizing structural damage.

Keywords: Steel Structure, Natural Frequency, Mode Shape, Damage Detection, Dynamic parameters

1 Introduction

Bridges are vital for a nations infrastructure, facilitating the movement of goods and people. Steel bridges are widely used for their durability and versatility but are susceptible to damage over time, including corrosion, fatigue, and external loads. Early detection and assessment of damage are crucial to maintaining the safety and longevity of these structures. Traditional inspection methods, such as visual inspections and manual tests, are